REMARKS

Favorable reconsideration of this application is requested in view of the foregoing amendments and the following remarks. Claims 1, 4, 6-12, 14-19, 33-46, 49, 52-59, 61-66 and 68-74 are pending in the application. Claim 51 is canceled without prejudice or disclaimer. Claims 2-3, 5, 13, 20-32, 47-48, 50, 60 and 67 were previously cancelled without prejudice or disclaimer.

On September 6, 2007 a telephone interview was held with the Examiner regarding this application. The courteousness extended by the Examiner is very much appreciated.

The claims are amended in order to more clearly define the invention, support for which is found in the figures and related parts of the specification. Support for the amendments to claims 1, 15, 33, 37, 49 and 62 is found at line 7 of paragraph 0053 and line 7 of paragraph 0073 and in figures 1-4.

Claims 1, 6, 7, 9, 10, 12, 14-19, 33, 34, 36-44, 46, 49, 51, 53, 54, 56, 57, 59, 61-66, 68, 70, 71, 73 and 74 were rejected under 35 USC 103 as being unpatentable over Alamouti et al. (US 6,853,629) in view of Fathallah et al. (US 6,381,053).

Claim 1 has been amended to require modulating a <u>single</u> carrier frequency of a direct sequence spread spectrum signal by fast frequency hopping. Claim 15 has been amended to require that the balanced modulator generates a direct sequence spread spectrum signal <u>and modulates a single carrier frequency of the direct sequence spread spectrum signal by fast frequency hopping.</u> Claim 33 has been amended to require direct sequence modulating the carrier signal to produce a hybrid spread spectrum signal <u>including modulating a single carrier frequency of the direct sequence pread spectrum signal by fast frequency hopping.</u> Claim 49 has been amended to require fast frequency hopping the signal with the fast hopping frequency

synthesizer to modulate a single carrier frequency of a direct sequence spread spectrum signal. Claim 62 has been amended to require a fast hopping frequency synthesizer coupled to the pseudo-random code generator, wherein the fast hopping frequency synthesizer modulates a single carrier frequency of a direct sequence spread spectrum signal by fast frequency hopping.

However, Fathallah explicitly teaches using broadband noise sources (e.g., amplified thermal noise) as main oscillators (his Figs. 4 and 10A and text at column 10, lines 11-37), which are ultimately bandpass-filtered to produce the final fast frequency-hopped signals. A broadband noise source is not the same as a single carrier frequency. Therefore the broadband noise source of Fathallah does not meet the claimed limitation of fast hopping modulation of a single carrier frequency.

The Examiner has previously agreed with Applicant (Office Action, ¶4) that **Alamouti, et al.**, (U. S. Patent No. 6,853,629), hereinafter "Alamouti", recites well-known textbook combinations of hybrid spread-spectrum (HSS) protocols, including DS/FH, DS/TH, FH/TH, and DS/FH/TH. Alamouti discloses a combination method for cellular (PCS-band) communications involving essentially conventional frequency-division duplex (FDD), time-division duplex (TDD), time-division multiple-access (TDMA), orthogonal frequency-division multiplexing (OFDM), spatial diversity, and polarization diversity. The system is based on a complex control scheme to simultaneously handle the FDD, TDD, and spatial and polarization diversity schemes using a multiplicity of sectorized, polarized antennas with beamforming electronics. The result has excellent fade resistance and good bandwidth efficiency, and permits changing a given user's bandwidth on demand by assigning additional TDMA slots during the user's session.

However, Alamouti never even mentions multiple frequency hops occurring within a single data-bit time where each bit is represented by characterized by multiple discrete carrier frequencies.

Alamouti (as cited by the Examiner in the latest Office Action, ¶5) also describes the use of polarization diversity, but conventionally assumes that in the use of polarization diversity the channel is essentially multipath-free, i.e., <u>that the two orthogonal polarizations are not intermixed by multipath or oblique reflections in the intervening paths between the transmit and receive antennas</u>. The intended use of polarization diversity by Alamouti, as described in his column 7, lines 29-38, states that the antennas "*are designed to <u>distinguish</u> orthogonally polarized signals. Signals exchanged between the base station and a first remote station are polarized in one direction, and signals exchanged between the base station and a second remote station are polarized in an orthogonal direction.*" The signals of the two remote stations are obviously presumed to be completely separable. This benign-path assumption, however, where the two orthogonally polarized signals are statistically independent (i.e., fully separable) is, however, ***not*** valid for the high-multipath environments addressed by the instant invention; for such, the methods of Alamouti to exploit the polarization diversity effect to obtain two clean channels will inevitably fail.

In contrast, claims 9-10, 33, 56-57 and 68 ***require*** the use of two time-synchronous (co-phased) orthogonally polarized waves (typically H and V), <u>each transmitting the same data</u>, to achieve the stated benefits of avoiding cancellation of the signal in highly reflective (multipath) environments (see instant ¶0042, ¶0072, and ¶0073). In general, due to the differing reflection coefficients in a high-multipath scenario for the independent H and V waves, at any given point in space if the H wave has a null, statistically the V wave will not. To exploit this fact, the instant

invention requires that the H and V waves be in exact time sync when launched. The *two-way* methods recited in Alamouti above will work properly only in benign, line-of-sight RF paths but will in general fail in non-minimum-phase or highly nonlinear-phase paths (e.g., in ***heavy*** multipath situations) since the multipath will often scramble the polarization relationships in the signals of Alamouti and the receiver will be unable to correctly resolve the incoming signal components and, consequently, the two data streams. Thus, Alamouti's polarization-diversity technique for base-remote communications (and vice versa) will usually fail in high-multipath and high-noise environments.

As cited by the Examiner (p. 2 of the current Office Action), Alamouti asserts (column 28, lines 38-45) that polarization-diversity receiving systems can provide an improvement over a single linear-polarization channel in a "strong" multipath environment. He goes on to state that a slant or circular polarization can be used in the corresponding transmitter, with little attendant performance loss. These observations are generally valid in many mild-to-moderate multipath environments such as in typical cellular-phone systems, where the received-signal power loss using slant or circularly polarized transmissions will still be at least 3 dB. However, in <u>extremely severe</u> multipath scenarios such as metal-lined industrial buildings, shipping-container handling yards, in urban canyons, and the like, the effective polarization of the signal is dynamically and continually ***controlled or modulated*** <u>*within the context of the overall fast-hopping HSS scheme*</u> of the instant invention to achieve the higher levels of composite process gain required to minimize data loss in these worst-case environments. This is accomplished by controlling the power levels of the two transmitted orthogonal signals signals (thus <u>modulating the effective polarization</u>), as cited in Claims 9, 10 56, 57, and 68 of the instant case. Finally, Alamouti utterly fails to disclose the use of fast frequency hopping (FFH) as described and claimed in the instant

invention, or any of the described interactions between the DS, FFH, THG, and polarization aspects of the composite HSS signal. Further, Alamouti never addresses modulating the polarization of the HSS signal.

Fatallah, et al. (U.S. Patent 6,381,053), hereinafter "Fathallah", presents an improved method and apparatus for optical and radio fast frequency hopping (FFH). To avoid the complexity and expense of conventional discrete-frequency high-speed synthesizer circuitry, especially difficult to implement for optical applications, Fathallah instead uses a simple broadband noise source for the local oscillator in both transmitter and receiver subsystems. The "multi-wavelength" [i.e., *multiple-frequency*] sources used by Fathallah are actually continuous bands of frequencies (derived from the random-noise generators) which are limited in bandwidth only by the channel-defining filters (e.g., his Fig. 19 and text at column 11, lines 26-31). (Obviously, the Fathallah architecture requires considerable amounts of optical encoder and decoder hardware for each user, whereas modern cellular systems perform these multi-user signal manipulations via software control in a common digital hardware block).

In his introductory text (column 1, lines 31-47) Fathallah discloses general methods of slow frequency hopping (SFH) [with ≤1 hop per bit] as well as FFH techniques [with >1 hop per bit]. Nevertheless, neither Alamouti nor Fathallah provide any insights whatsoever in combining these techniques to produce a useful (much less synergistic) DS/FFH combination methodology as in the instant case. Fathallah actually ***teaches away*** from the use of conventional fast-hopping protocols due to the high circuit complexity and speed requirements for the FFH synthesizer hardware, and resulting cost; these issues affect both transmitters and receivers. To solve these problems, particularly with respect to optical data-transmission applications, Fathallah discloses systems using inexpensive broadband noise sources (e.g., amplified

thermal noise) as main oscillators (his Figs. 4 and 10A and text at column 10, lines 11-37), which are ultimately bandpass-filtered to produce the final fast frequency-hopped signals.

It must be noted, however, that the use of such broadband signals as carriers is simply not compatible with the operational requirements of most RF systems (<u>including Alamouti's</u>), which must have precisely defined (and tightly spaced) channels. In conventional RF systems, the effective bandwidth of the coherent carrier-signal sources (i.e., from crystal-controlled oscillators or synthesizers) are much, much less than the intended channel bandwidth (e.g., ~10 kHz in a 1-MHz channel, for a 40-dB transmitted SNR). Fathallah, by contrast, would utilize a transmitted noise bandwidth only slightly smaller than the channel bandwidth, thus drastically reducing the effective SNR (to ~10 dB at best) and *precluding* any coherent (synchronous) detection schemes which could give best link performance (as in Alamouti and the instant case). The non-coherent detection thus required is indeed cheaper but not without a significant (~3-dB) performance penalty. Further, the use of Fathallah's broadband signals will cause substantial inter-channel leakage (i.e., adjacent-channel interference, ACI) in most typical multi-user RF systems, which are based on <u>pure sinusoidal</u> (*single-frequency*) <u>RF carriers</u>. This is especially true of the hybrid cellular-type multi-user DS/FH system of Alamouti, in which the broadband, random-noise spreading inherent in Fathallah's noise-type signal sources will greatly interfere with and degrade (and likely even obliterate) the pseudorandom but highly deterministic PN codes of the DS signal components used in Alamouti. Further, the non-coherent detection dictated in Fathallah is incompatible with the need for coherent detection to optimize multi-user performance in cellular systems. **The use of Fathallah's techniques in the system of Alamouti will thus greatly reduce the link SNR and radically increase the multiple-access noise, thus markedly impairing the inter-user orthogonality**

and reducing the system user capacity and overall performance! ***Thus, Fathallah's techniques cannot be advantageously applied to the system of Alamouti!*** Conversely, Fathallah teaches away from conventional hardware systems such as Alamouti and the instant invention due to cost and complexity concerns; thus, his use of filtered-and-delayed ***noise bands*** rather than discrete-frequency (sinusoidal) carrier signals. ***In contrast***, the instant invention solves this latter problem via the use of direct digital synthesis (DDS) circuits to directly generate the fast signal carrier hops in an open-loop, nearly instantaneous manner and thereby inherently avoid the well-known speed limitations of conventional feedback frequency-synthesizer architectures.

Finally, even if one where to combine the techniques of Alamouti and Fathallah, the resulting amalgamation would still not meet the claimed limitation of wherein multiple frequency hops occur within a single data-bit time and each bit is represented by chip transmissions at multiple carrier frequencies. Alamouti et al and/or Fathallah et al., alone or in combination, do not disclose or suggest to one of ordinary skill in the art of RF engineering to modulate a single carrier frequency of a direct sequence spread spectrum signal by fast frequency hopping, wherein multiple frequency hops occurring within a single data-bit time where each bit is represented by chip transmissions at multiple carrier frequencies.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 4, 35, and 52 were rejected under 35 USC 103(a) as being unpatentable over Alamouti (US 6,853,629) in view of Fathallah (US 6,381,053) further in view of Swanke (US 5,521,533).

The Swanke reference does not obviate the deficiencies of Alamouti et al. and/or Fathallah et al.. Namely, Swanke, Alamouti et al and/or Fathallah et al., alone or in combination,

do not disclose or suggest to one of ordinary skill in the art of RF engineering to modulate a single carrier frequency of a direct sequence spread spectrum signal by fast frequency hopping, wherein multiple frequency hops occurring within a single data-bit time where each bit is represented by chip transmissions at multiple carrier frequencies.

Swanke (U. S. Patent No. 5,521,533) only shows the use of a DDS in a basic frequency-hopping context, or two such devices in order to reduce the normal levels of spurious RF output signals to negligible amounts. Swanke never mentions any modulation form except basic (slow) FH, much less the composite HSS form of the instant invention. Swanke does not obviate the above deficiency of Alamouti and Fathallah.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 8, 55, and 72 were rejected under 35 USC 103(a) as being unpatentable over Alamouti (US 6,853,629) in view of Fathallah (US 6,381,053) further in view of Beard (US 7,230,971).

The Beard reference does not obviate the deficiencies of Alamouti et al. and/or Fathallah et al.. Specifically, Beard, Alamouti et al and/or Fathallah et al., alone or in combination. do not disclose or suggest to one of ordinary skill in the art of RF engineering to modulate a single carrier frequency of a direct sequence spread spectrum signal by fast frequency hopping, wherein multiple frequency hops occurring within a single data-bit time where each bit is represented by chip transmissions at multiple carrier frequencies.

Beard, U.S. Patent 7,230,971, discloses a method for selecting a pseudorandom sequence for a typical frequency-hopping spread-spectrum system (i.e., Bluetooth in the 2.45-GHz ISM band), in which specific channels in the possible hop set are associated with distinct pseudorandom sequences selected from the total set. The overall goal is to sufficiently

randomize the channel sets on a dynamic basis (using clear channels, noisy channels, time intervals, channel occupancy histories, etc.) to prevent signal interception and provide hardware and power-consumption efficiencies. Specifically intended for FH systems, Beard shows no linkage whatsoever to DS or HSS systems. The statistics of multi-user DS/HSS systems such as in Alamouti or in the instant invention are markedly different from the simple anti-collisional needs of the straightforward FH system of Beard; thus, while Beard's approach should work in the FFH system of Fathallah, it would have little use in that of Alamouti due to the characteristics of the overlapping users' signals in channel sharing DS-type CDMA systems such as Alamouti's. CDMA (either DS or HSS) systems do not need to look for "empty" channels like simple FH systems, since the DS process gain and code orthogonalities can serve to effectively separate different users' signals and are thus not subject to the constraint of hoppers that collisions between users destroy both data packets. The use of Beard's techniques in the system of Alamouti would result in major conflicts with the sophisticated channel-allocation schemes employed to separate Alamouti's users and at best would drastically reduce the capacity and bandwidth efficiency Alamouti's methodology were designed to maintain and, indeed, even maximize. ***Thus, not only is Beard irrelevant to DS systems, but his techniques, if applied, would greatly degrade the performance of DS (and HSS) systems such as Alamouti's or that of the instant invention!*** Thus, Beard does not obviate the above-cited deficiencies of Alamouti and Fathallah.

Accordingly, withdrawal of this rejection is respectfully requested.

Claims 11, 45, 58, and 69 were rejected under 35 USC 103(a) as being unpatentable over Alamouti (US 6,853,629) in view of Fathallah (US 6,381,053) further in view of Becker (US 6,726,099). Alamouti, Fathallah, and/or Becker simply do not disclose or suggest the claimed

limitation of multiple frequency hops occurring within a single data-bit time where each bit is represented by characterized by multiple discrete carrier frequencies.

The Becker reference does not obviate the deficiencies of Alamouti et al. and/or Fathallah et al.. Namely, Becker, Alamouti et al and/or Fathallah et al., alone or in combination, do not disclose or suggest to one of ordinary skill in the art of RF engineering to modulate a <u>single</u> carrier frequency of a direct sequence spread spectrum signal by fast frequency hopping, wherein multiple frequency hops occurring within a single data-bit time where each bit is represented by chip transmissions at multiple carrier frequencies.

Becker, et al., U.S. Patent 6,726,099 (hereinafter, Becker) discloses a bidirectional spread-spectrum RFID system using simple frequency hopping on the tag-to-reader RF link and standard direct-sequence spreading on the reader-to-tag transmissions (column 4, lines 45-58; column 6, lines 62-67 through column 7, lines 1-7). The DS and FH modulations of Becker are never used together on the same link, and no specific relationship between these component modulations is ever established. Becker never discloses true time-hopping modulation in conjunction with multiple frequency hops occurring within a single data-bit time where each bit is represented by chip transmissions at multiple carrier frequencies, but instead pre-selects frequency channels and time slots for transmissions to minimize mutual interference among tags in his system, although he does disclose an optional pseudorandom selection of his tag transmission time slots. Thus, Becker never discloses the <u>concatenated hybrid spread-spectrum</u> methods of the instant invention, only <u>existing-art</u> spread-spectrum transmission techniques. Finally, Becker does not obviate the above deficiencies of Alamouti and Fathallah.

Accordingly, withdrawal of this rejection is respectfully requested.

In conclusion, none of the references applied by the Examiner disclose or suggest the claimed limitation of modulating a single carrier frequency of a direct sequence spread spectrum signal by fast frequency hopping, wherein multiple frequency hops occurring within a single data-bit time where each bit is represented by chip transmissions at multiple carrier frequencies or the specific claimed combinations of this feature with direct-sequence, direct-sequence/time-hopping, direct-sequence/time-hopping/polarization-hopping, or direct-sequence/polarization-hopping, nor their specific implementations or advantages in solving the explicitly described problem of communicating in a severe multipath-plagued signal-propagation environment.

Other than as explicitly set forth above, this reply does not include acquiescence to statements in the Office Action. In view of the above, all the claims are considered patentable and allowance of all the claims is respectfully requested. The Examiner is invited to telephone the undersigned (at direct line 928-226-1073) for prompt action in the event any issues remain that prevent the allowance of any pending claims.

The Director of the U.S. Patent and Trademark Office is hereby authorized to charge any fees or credit any overpayments to Deposit Account No. 50-3204 of John Bruckner PC.

Respectfully submitted,

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